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CENTRAL PLANT LABORATORIES OF USSR BASIC CHEMICAL INDUSTRY

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For the purpose of regulating the work of central plant laboratories (TsZL) and of technical control departments (OTK) at plants of the Ministry of the Chemical Industry, "Standard Instructions Regarding Central Plant Laboratories and Technical Control Departments" were placed into effect as of 1944. These instructions anticipate organization of TsZL at all plants of the ministry and defines the TsZL as the leading agency of the enterprise. The general task of the TsZL, which functions under the direct supervision of the chief engineer, consists of devising and carrying out measures facilitating execution of the production plan, as well as introducing improvements into the work of the enterprise.

A TsZL comprises the following subdivisions: scientific research, operations investigation, production control, analytical, auxiliary groups, and laboratories. The principal function of the OTK is control and supervision over the quality of production in accordance with existing standards and technical norms. The OTK operates under the supervision of the plant director.

The shop for testing and measuring instruments (KIP shop) operates on the basis of special instructions. It comes under the supervision of the chief engineer and is one of the most important shops of the plant.

Thus, the existence of three independent organizations has been provided for at chemical plants. The TsZL and KIP shops are concerned with the rationalization of technical-process control, while both the TsZL and OTK control product quality.

GIPROKHIM (State Planning Institute for the Chemical Industry) has worked out a typical project of a central laboratory to be occupied by the TsZL, OTK, and the KIP shops. Since chemical plants differ widely with respect to capacity

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and type of production (for instance, a superphosphate plant is engaged in only two or three types of production, while a chemical combine comprises ten or more types), it would not be advisable to have exactly the same laboratory at all plants. For this reason, two types of TsZL have been projected.

A TsZL of the first type (for small plants) consists of the following subdivisions: scientific research, analytical control, and economic. Chief of the TsZL is an engineer-technologist. He is in immediate charge of the scientific research department. The staff of the analytical control group should be composed of qualified analytical chemists who have adequate experience in laboratory work, because the analyses to be carried out are very diverse and the problems encountered are often of a research type. The research staff may consist of the director, who should be a qualified engineer-technologist with production experience, and young specialists. The total staff of a TsZL of the first type consists of 15-20 people.

As the capacity and number of production branches grow, the scope of activity of the TsZL and OTK increases.

The organization of a TsZL of the second type provides a separate analytical department which is independent of the department of production control, the latter supervising the work of the plant laboratories. The staff of the research department consists of the chief as well as engineers and technicians working under his direction. The total personnel of laboratories of the second type consists of 45-50 people.

The scope of work of the analytical OTK laboratory is determined by the number of types of production, as well as the number of batches of crude material, final products, and intermediate products. At superphosphate plants, the crude and final products amount to three or four. Furthermore, the number of analyses depends on the size of the batches (or shipments) to be analyzed.

The number of analyses to be carried out by an OTK laboratory per year is determined on the basis of all these factors. All these data are broken down, arranged, and tabluated. Computation of the number of analysts is carried out on the basis of the standard time required for a single analysis, as well as the time required by individual analysts. To determine these standards, the plants must be inspected.

Determination of the standard time per analysis is complicated and inconvenient. Determination of the standard time per analyst leads to varying results: at one of the operating plants, the standard amounts to 220-250 analyses a month (depending on the qualifications of the analyst); at another, 210-220; and at a third, up to 300. These standards of performance depend on the complexity of the analyses and some other factors.

The size of the staff of analysts is best computed on the basis of standards of performance, assuming there are 11 working months (280 working days) per year. In our (GIPROKHIM) projects, the standard of performance is assumed to be 200 analyses a month or 2,200 a year. The number of samplers and controllers of the OTK is determined according to the practical needs of the plant in question.

The volume of work of the KIP shop, and the size of its staff are determined on the basis of the plant's capacity and the number of types of production. The staff of the KIP shop includes the chief, instrument technicians, laboratory technicians, fitters, electricians, and a constructor. In the case of superphosphate plants, the KIP staff amounts to 25 people. Plants of the second group have 40 people. Figures for the total staff are tabulated, but the number of people working in the first shift is indicated. The total figures are necessary for estimating utilities, consumption of water, etc.

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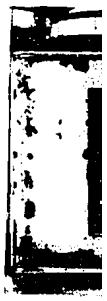

Calculation of Areas

The TsZL building is designed to accommodate the following rooms, depending on the activities planned: chemical laboratories of TsZL and OTK, additional rooms for laboratories, administrative offices, rooms for the KIP shop, auxiliary rooms, special rooms.

In chemical laboratories, each analyst is provided 1.5 m of table space. Every analyst is assumed to require 0.8 m c. hood-space front. These figures are doubled for research laboratories. Two OTK analysts use one set of analytical balances. At the TsZL laboratory, one balance is assigned to from three to four analysts and /or?/ four research workers.

The minimum number of titrated solutions at TsZL is ten, corresponding to a table length of 5 m (0.5 m per solution). The area per person is fixed at 10-11 sq m.

For a standard-type laboratory at superphosphate plants, the following have been projected:

1. Research laboratories: two rooms of 21.8 sq m, each room for two persons.

2. Analytical laboratory of TsZL (43.0 sq m) for four persons.

3. Analytical laboratory of OTK (76 sq m) for seven persons.

4. Preparative laboratory with a work space of 21.8 sq m for an individual engaged in preparations. Additional space for bottles is required in this case.

5. Calorimetric laboratory, which is used for determining the calorific value of fuel. This laboratory, with an area of 10.0 sq m is occupied by one person.

Among auxiliary laboratory rooms, the following may be indicated:

1. Balance room for the common use of all laboratories, with an area of 21.0 sq m. Contains five tables for analytical balances.

2. Room for titrations (21.0 sq m). Total table length, 7.5 m, corresponding to 15 bottles with solutions.

3. Room for sifting samples (10.0 sq m).

4. Distillation room (10.0 sq m) for preparing distilled water.

5. Room for washing glassware.

6. Hydrogen sulfide laboratory (two rooms with a total area of 20.5 sq m).

7. Room for preparing samples (21.0 sq m), to be used simultaneously by two persons.

The following have been projected for the KIP shop: room for preparing, cleaning, and finishing instruments; mechanical workshop which also serves TsZL (area of the workshop 40 sq m), pyrometric laboratory (44 sq m), two laboratories (21.0 sq m each), one for control work and one for overhauling precision instruments, office space (21.0 sq m). and storage room for spare parts and equipment.

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The total area of the KIP shop, excluding storage space, is 173.0 sq m, i.e., there are 11.5 sq m of laboratory space per person. This area is to be used by 15 men; the rest of the personnel of the KIP shop (ten persons) work constantly at the production shops /departments/.

Auxiliary space to be used as storage rooms, supply rooms, library, workshops, etc., is provided. There are no standards for projecting storage rooms. The number of storage rooms at a typical standard project is four, while the number of supply rooms is two. The storage facilities for laboratory glassware and equipment consist of two rooms having a total area of 41.3 sq m. The storage room for reagents has an area of 20.5 sq m; the supply room for acids, 22.0 sq m; the supply room for inflammable reagents, 18 sq m; the storage room of the KIP shop, 20.5 sq m; and the repository for samples, 10.0 sq m. The dimensions of the supply rooms for acids and inflammable reagents can be halved, but the rooms can be used only for the purpose for which they were designed. Laboratory glassware and reagents should be kept in the vicinity of the TsZL.

The library consists of a book repository (21.5 sq m) and a reading room (43.5 sq m). The standard capacity of the book repository is 400 volumes per square meter; consequently, the available space may accommodate 400 x 21.5 or 8,600 volumes. The reading room is also to be used for conferences, technical instruction, etc.

The standard project provides two workshops: one for glass blowing (21.4 sq m) and the other to be used as a mechanical workshop (40.6 sq m). The mechanical workshop is chiefly at the disposal of the KIP shop, so that its area is determined by the size of the staff of KIP.

The rooms for accommodating sanitary-technical and power equipment, i.e., the indraft ventilation chamber, the carburetor room, and the transformer substation are of varying design. The area of the indraft ventilation chamber is determined by sanitary technicians on the basis of standard equipment. The carburetor room (20.2 sq m), which is dangerous from the standpoint of the possibility of fires and explosions, must be isolated. The transformer substation, with an area of 24.3 sq m, is projected according to standard specifications. Placing the transformer substation in the TsZL building is a variation of the plan for the particular case of superphosphate plants. Since the TsZL building is the largest power consumer in the group of buildings in question, location of the transformer substation in this particular building is advisable. The auxiliary rooms occupy about 50% of the useful space of the TsZL building.

Planning of Rooms

The TsZL building is designed as a two-story building with a basement. The building is rectangular with a central passage along its whole length. The building's dimensions along the axes are 36.0 m x 14.6 m. Laboratories, the library, and administrative offices are on the second floor. The first floor consists of the KIP shop, miscellaneous workshops, the room for the preparation of samples, the repository for samples, and rooms for general use. Storage rooms and the indraft ventilation room are in the basement, the exhaust ventilators in the attic.

The main entrance is in the middle of the building in front. The second entrance is in the middle of the building in the back. There are two exits from the basement: one at a narrow end of the building and one leading to the staircase landing in the center of the building. At the narrow ends of the building, there are two fire escapes from the second floor.

Planning of rooms in a laboratory of the second type is carried out according to the same principle.

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In planning, one must consider the necessity of establishing proper connections between rooms from the operational standpoint; observe safety (fire, etc.), building, sanitary-technical, and labor-protection standards; and take into account that three independent organizations must be located in the same building under the most efficient utilization of space. One must also take note of (1) the location of the TsZL with respect to the general plan, (2) the architectural and construction peculiarities of the building, (3) special requirements which must be fulfilled within the scope of standard TsZL projects, and (4) conditions of plant operation and relations between the TsZL and production departments.

Location of Equipment

In disposing the equipment in individual rooms, one must take account of the fact that laboratory working space must be equipped with water, gas, and electric power outlets, as well as drainage. For that reason, laboratory furniture should be placed along partitions which are parallel to the outer wall. Double laboratory tables are placed close to the outer wall so that they are in contact with it. Exhaust-hood cabinets are behind the laboratory tables. Placing of exhaust-hood cabinets in the immediate vicinity of windows darkens the rooms and the laboratory tables and, furthermore, necessitates long air conduits, because the exhaust ventilators are in the highest part of the attic, i.e., above the passages.

The tables for heating appliances are placed as closely as possible to the exhaust hoods to prevent the laboratory air from becoming contaminated by fumes coming from muffle furnaces. Some plant chemists are of the opinion that muffle furnaces should be installed in the exhaust-hood cabinets. This actually should be done if some particularly harmful or poisonous gases are evolved. Titration tables should be placed, just like laboratory tables, along the partitions. Tables for analytical balances are supported by brackets fixed to the main walls.

Sanitary-Technical and Power Equipment for Laboratories

Laboratory tables and hood cabinets have the following connections: water, one faucet each, and, over the sinks of laboratory tables, two or three laboratory water-supply connections; gas, two ordinary faucets; electrical connections, three plug sockets for heating devices per laboratory table and four or five per hood cabinet.

Compressed air is fed to the glass-blowing shop, preparative laboratory, and research laboratories. Vacuum is obtained by using water ray pumps. For high vacuum work, a VN-461 vacuum pump is installed in the analytical laboratory. Three-phase current of 0.25-0.5 kw is supplied by means of one outlet each to research laboratories and analytical TsZL for the use in various devices. The sanitary-technical equipment of TsZL of the second type, as compared with TsZL of the first type, is supplemented by hot-water outlets at every washstand, one or two distilled-water outlets in every laboratory, one outlet for vacuum with a residual pressure of 150-160 mm at every laboratory table and hood cabinet, and compressed-air outlets at every laboratory. Furthermore, the number of laboratory water-supply outlets at laboratory tables and exhaust-hood cabinets is increased.

The area of analytical laboratories is increased in accordance with increases in the staff. The area of research laboratories is not increased but their number is augmented. The area of auxiliary rooms like the library, carburetor room, glass-blowing shop, inflow-ventilation chamber, cloak room, and shower room remains unchanged.

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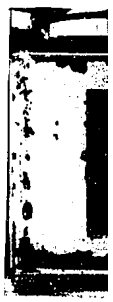


Laboratory Furniture

Laboratory furniture is nonstandardized equipment which is made at the plant itself. For that reason, submission of work drawings of laboratory furniture by project organizations is obligatory. However, it is not quite clear to what extent such drawings should be prepared.

The committee on architectural matters has published a book of drawings of standard windows and doors. It is necessary to publish a book of standard laboratory furniture as well.

Basic laboratory furniture is supplied in the following sizes and types:

1. Laboratory table of 3000 x 750 x 900 mm; total height with counter 1,530 mm; includes four cupboards and 12 drawers. Surface covered with linoleum.

2. Laboratory table of 2270 x 750 x 900 mm; same height as above; with three cupboards and nine drawers.

3. Hood-exhaust cabinets are also of two sizes, with two or three sash frames of 2,400 x 800 x 2,600 mm or 1,650 x 800 x 2,600 mm. The table surface under the hood is covered with tiles ("Metlach" tiles).

4. The tables for analytical balances are boards of hardwood held on brackets. Below the table, there is a drawer for weights. The dimensions of the tables are 1,000 x 500 mm.

5. Titration tables have counters equipped with shelves for holding bottles. The dimensions of titration tables are 2,500 x 600 x 900 mm; the total height of the tables, including counters is 1,770 mm. A table accommodates five bottles. Any table can be used as a titration table; these tables are placed next to a partition so that the shelves can be fixed to the partition.

6. Table for heating appliances, 1500 x 750 x 900 mm; covered with tiles. For convenience in operating furnaces, height of table should be 1.1 m.

7. Table for washing dishes, 2,500 x 800 x 800 mm; equipped with lead sink and drain connected with waste line. A wooden grating is placed at the bottom of the lead sink.

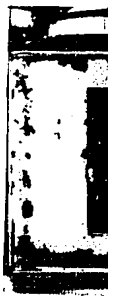
8. Supply cupboard, 1,500 x 650 x 2,000 mm, with upper part of doors of glass. Used for keeping apparatus and reagents.

9. Storage cupboard, 1,500 x 650 x 1,800. Has bottom drawer extending across the whole width of the cupboard for storing burettes and pipettes.

Nonstandardized Equipment

Besides furniture, the industry supplies diverse small-sized equipment for laboratory use. This equipment is described in part in old catalogues and various laboratory manuals.

Much effort is spent in laboratories in connection with the building and making of various devices. Appliances used most often should be standardized, as, for instance, water baths, steam baths, sand baths, electric heating ranges for mass analyses [i.e., analyses of a large number of samples], supports, stands, equipment for making distilled water, stands for mass filtrations and mass determinations, closets for drying dishes, and other appliances which expedite and facilitate laboratory work.



Specification of laboratory equipment is made difficult by the absence of a single catalogue comprising laboratory equipment, dishes, and apparatus. The price and order list, price-list catalogues, and reference catalogues of laboratory equipment all suffer from the same fault: they do not list completely all the equipment required in laboratories. Appliances like potentiometers for p_H determinations, polarographs, nephelometers, electrically heated oil tanks /baths?/, laboratory vacuum pumps, devices for work on gas and gasoline, and devices for potentiometric titrations cannot be found in any catalogue.

Devices and apparatus are listed in catalogues by parts, not as a complete apparatus. Thus, Dean and Stark's apparatus for the determination of water in petroleum is listed in the price and order list (Issue 3, division VIII) in the following manner: the flask in paragraph 357, the condenser in paragraph 474, and the trap in paragraph 581. All parts of an apparatus should be listed together.

It is absolutely essential to compile a complete catalogue listing all laboratory apparatus, devices, glassware, auxiliary equipment, etc., indicating size, standards, the fact that some unit is a part of a certain apparatus, cost, and source of supply.

A project organization cannot be expected to institute a search for work drawings and technical standards in the case of every article used in a laboratory. While it is inexpedient to draw up projects for this type of equipment, such equipment must be included in specifications.

Architectural and Building-Construction Aspects

In accordance with OST (All-Union Standard) 90015-39, TsZL buildings belong to categories A or B and must be fireproof. A typical TsZL project for superphosphate plants comprises two stories and a basement. The building is rectangular, with side dimensions of 36.0 x 14.6 m. The inside height of the rooms is 3.9 m, the basement, 3.05 m. The side dimensions for the second type are 52.0 x 14.6 m.

Planning laboratories with smooth concrete floors covered with linoleum is undesirable, since linoleum is only partly fire-resistant and deteriorates rapidly when strong acids are used in production laboratories. It might be desirable to suggest to building organizations that they develop more perfect floor coverings which would satisfy all demands put by chemists.

The TsZL building is placed with reference to the general ground plan in such a manner that it is protected from harmful gases and dust. As a rule, it should be situated on the main road passing through the territory of the plant.

Ventilation

The ventilation, of the indraft-exhaust type, is mechanically impelled. Exhausting is carried out basically through the laboratory hoods. The quantity of air exhausted through the hoods is determined on the basis of the air velocity of 0.7 m/sec established in the open cross section of the working aperture. For exhaust hoods installed in the gas (hydrogen sulfide) laboratory, this velocity is assumed to be 1 m/sec.

Indraft air is supplied mainly to the passages of the first and second floors and into rooms which do not have any exhaust ventilation. Into rooms occupied by laboratories, indraft air is supplied only in a quantity sufficient to compensate for the total air exchange. Into the carburetor and glass-blowing rooms, air is supplied in a quantity replacing 80% of the exhausted air.

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To insure free circulation of indraft air from the passages into the laboratories, Venetian-blind gratings are provided for the upper parts of laboratory doors. In the winter, indraft air is heated to + 18° by means of plate heaters.

Electrical Equipment for Illumination

The working illumination is both general and local. Local illumination is brought about by the following means: (a) on every laboratory table, there are two brackets of the turning type with Al'fa fittings and 40-w lamps; (b) on every balance table, there is one bracket with Al'fa fittings and a 40-w lamp; (c) on every titration table, there are two daylight fluorescent lamps of 15 w each; and (d) in every exhaust-hood cabinet, there is a porcelain semihermetic /safety/ fitting holding a 60-w lamp.

Electrical Equipment for Heating Devices

The laboratories are equipped with the following heating appliances:

1. On every table for heating appliances, arrangements are made for installing two 2.4 and /or?/ 2.6-kw devices.

2. On every laboratory table, there are three 600-w plug sockets used for connecting small portable devices.

3. On every exhaust-hood cabinet, there are from four to five plug sockets, depending on the length of the cabinet. The sockets, affixed to the outer walls of the cabinets, are for connecting heating appliances up to 600 w.

4. In the glass-blowing shop there is a 4-kw tempering furnace.

5. A 12-kw electrical distiller is provided for the distillation room.

In addition to the above-mentioned devices not using more than 600 w, the connection in any laboratory of one 1.2-kw heating device through any of the plug sockets there is provided for. Feeding of all distribution points of the whole network of heating devices proceeds through a single feeder. For feeding the electrical distiller, a separate feeder is provided.

The exhaust-ventilator motors are installed in the attic and are controlled from the laboratories. There are also local control points for the ventilator motors, to be used at times when repair work is carried out.

An alternate scheme of feeding is provided for the case of a transformer substation which is outside the building.

According to regulations establishing standard conditions, TsZL is supposed to be the leading agency of the enterprise. Actually, at a number of plants, the CTK do not have their own analytical laboratories, so that most TsZL workers carry out control analyses. It is necessary to try to transform plant laboratories into affiliates of scientific research institutes. This will insure correct selection, according to plant groups, of scientific research problems to be solved and, furthermore, will guarantee that the work in question is carried out under systematic direction.

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